DEPARTMENT OF AGRICULTURE.
BUREAU OF ENTOMOLOGY—BULLETIN No. 96, Part V.
L. O. HOWARD, Entomologist and Chief of Bureau.

ON INSECTS AFFECTING STORED PRODUCTS.

THE BROAD-BEAN WEEVIL.

BY

F. H. CHITTENDEN, Sc. D.,
In charge of Truck Crop and Stored Product Insect Investigations.

[With Reports by WM. B. PARKER, *Agent.*]

ISSUED AUGUST 6, 1912.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1912.

BUREAU OF ENTOMOLOGY.

L. O. HOWARD, *Entomologist and Chief of Bu*
C. L. MARLATT, *Entomologist and Acting Chief in Abs*
R. S. CLIFTON, *Executive Assistant.*
W. F. TASTET, *Chief Clerk.*

F. H. CHITTENDEN, *in charge of truck crop and stored product inse*
A. D. HOPKINS, *in charge of forest insect investigations.*
W. D. HUNTER, *in charge of southern field crop insect investigation*
F. M. WEBSTER, *in charge of cereal and forage insect investigations*
A. L. QUAINTANCE, *in charge of deciduous fruit insect investigation*
E. F. PHILLIPS, *in charge of bee culture.*
D. M. ROGERS, *in charge of preventing spread of moths, field work.*
ROLLA P. CURRIE, *in charge of editorial work.*
MABEL COLCORD, *in charge of library.*

TRUCK CROP AND STORED PRODUCT INSECT INVEST

F. H. CHITTENDEN, *in charge.*

H. M. RUSSELL, C. H. POPENOE, WM. B. PARKER, H. O. MA
FRED. A. JOHNSTON, JOHN E. GRAF, *entomological assistants.*
I. J. CONDIT, *collaborator in California.*
P. T. COLE, *collaborator in tidewater Virginia.*
W. N. ORD, *collaborator in Oregon.*
THOS. H. JONES, *collaborator in Porto Rico.*
MARION T. VAN HORN, PAULINE M. JOHNSON, ANITA M. BALLIN

CONTENTS.

ILLUSTRATIONS.

PAPERS ON INSECTS AFFECTING STORED PRODUCTS.

THE BROAD-BEAN WEEVIL.

(*Laria rufimana* Boh.)

By F. H. CHITTENDEN, Sc. D.,

In Charge of Truck Crop and Stored Product Insect Investigations.

[With Reports by WM. B. PARKER, *Agent.*]

INTRODUCTORY.

This species, which is commonly known as the bean beetle or bean-seed beetle in Europe, where it has been a pest for a great many years, has frequently been brought to the United States and Canada in its food supply. Until the year 1909, however, there was no positive proof known to the writer of its ever having been introduced into North America. This is most remarkable considering the number of times that it has been imported living—almost yearly in all probability—and that the species is so well established in Europe, where it is a common and destructive pest. It especially infests broad beans, and, it is said, peas and some other legumes. Broad beans, it might be explained, are also known under the names of horse, Windsor, tick, and "English Dwarf" beans. During 1909 and since, this species has become established in several localities in California, and bids fair to become a most formidable drawback to the cultivation of broad beans in that State, if not in the entire country where this crop is raised.

DESCRIPTION.

THE ADULT.

The species under consideration, *Laria rufimana* Boh., although very closely related to the pea weevil (*L. pisorum* L.), is readily separable by the following characters, expressed in tabular form:

Posterior femora acutely dentate; thorax broad; pattern of elytra well defined; pygidium with a pair of distinct apical black spots..... *pisorum* L.

Posterior femora obtusely or obsoletely dentate; thorax narrow; pattern of elytra more or less suffused; pygidium with black apical spots lacking or illy defined, *rufimana* Boh.

While there is no great difference in the size of the two species, *pisorum* averages a little larger. The following technical description of *rufimana* is adapted from Horn:

Oblong oval, black, subopaque. Head black, densely punctulate, sparsely clothed with ochreous pubescence. Antennæ black, four basal joints rufous. Thorax wider than long, sides moderately rounded in front of tooth, sinuate behind it, tooth at middle obtuse, moderately prominent; surface opaque, densely punctate, and with a small whitish triangular space in front of scutellum. Scutellum subquadrate, emarginate at apex, sparsely clothed with cinereous hairs. Elytra longer than wide, feebly convex, sides moderately rounded, surface more shining than the thorax; moderately striate, intervals flat, densely punctulate, and with the basal margin, base of suture, and two irregular transverse bands of whitish hairs. . Pygidium clothed with cinereous hairs and with two nearly obsolete oblong black spots. Body beneath black, densely punctulate, and clothed with cinereous hairs. Anterior legs rufous, except their tarsi, apex of tibiæ, and base of femora, which are piceous. Middle and posterior legs black.

Length: 0.14–0.18 inch (3.5–4.5 mm.); width: 0.8 inch (2.4 mm.).

The synonymy of this species is as follows:

Laria rufimana Boh.

Bruchus rufimanus Boh., Schœnherr, Gen. et Spec. Curculionidum, vol. 1, p. 58, 1833.
Bruchus granarius auct. (*non* Linnæus), Westwood, Curtis, Ormerod, Wood, Riley, Fletcher, Lintner, *et al.*
Mylabris rufimana Boh., Baudi, Deutsch. Ent. Zeitschr., 1880, p. 404.
The *Bruchus granarius* L. is *Laria atomoria* L.; Syst. Nat., 12th ed., p. 605, 1766–1768.

The beetle is shown in figure 11, and figure 12, representing the pea weevil, is introduced for comparison.

FIG. 11.—The broad-bean weevil (*Laria rufimana*): Adult or beetle. Enlarged. (Original.)

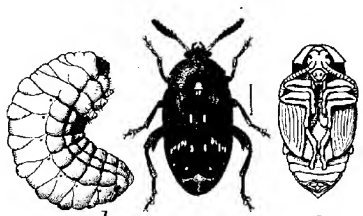

FIG. 12.—The pea weevil (*Laria pisorum*): *a*, Beetle; *b*, larva; *c*, pupa. Enlarged. Author's illustration.

From Mr. I. J. Condit, San Luis Obispo, Cal., under date of April 18, 1911, were received the eggs of this species found on young pods of the broad or horse bean (*Vicia faba*). The pods were just beginning to form in many cases, some being as long as 2 inches. In some cases as many as nine eggs were found on one small pod and one was observed on the withered calyx lobe of the flower. Few beetles were observed and none was detected in the direct act of oviposition. Evidently this is accomplished mainly at night.

THE EGG.

The eggs are deposited upon the outside of the pod, usually without reference to the position of the young beans, and are firmly attached to the epidermis by a glutinous, adhesive secretion, which usually remains as an enveloping border or fringe, as shown in figures 13 and 14. They are deposited singly over the surface of the pods. As many as nine may be deposited upon a single pod, although from four to six appear to be more usual in the cases observed.

FIG. 13.—The broad-bean weevil: Photomicrograph of egg. (Original.)

The egg is elliptical-ovate, about twice as long as wide, rounded at the extremities, and somewhat more pointed anteriorly. The surface is smooth and polished, without visible sculpture. In color it is clear greenish yellow when fresh, but just before hatching the dark head of the embryonic larva becomes plainly visible through the thin shell. It is 0.55 to 0.60 mm. in length by 0.25 to 0.28 mm. in width.

The description of the egg was made from specimens just before hatching and the greenish color may have been absorbed from beneath, since Mr. Condit states that the egg when first seen is watery white, glistening in the light. It is large and, like the eggs of our other injurious Lariidæ, plainly visible to the unaided eye.

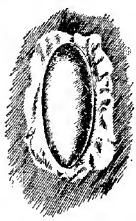

FIG. 14.—The broad-bean weevil: Egg. Greatly enlarged. (Original.)

THE POSTEMBRYONIC LARVA.

The young larva emerges through a round hole in the underside of the egg and bores at once into the young beans, going directly through the pod.

FIG. 15.—The broad-bean weevil: Apical crest of head of postembryonic larva. Greatly enlarged. (Original.)

When first hatched it is pale yellow, with brownish or blackish head and mouth-parts. Except in the shape of the prothoracic spinous processes, it differs little from the larva of the pea weevil (*Laria pisorum* L.). These processes are shown in figure 15.

DISTRIBUTION.

The distribution of this weevil in Europe is given by late authority as middle and southern. The species is also known to be established in Austria, Spain, Italy, southern France, Sardinia, the Crimea, Egypt, Syria, Algeria, and Tunis, and it has long been credited with being a pest in England. It is also recorded from Teneriffe, Canary Islands.

During 1893 the writer found this species commonly in many exhibits of broad or Windsor beans at the World's Columbian Exposition held at Chicago, Ill., during that year; indeed, the exhibits of these last two varieties of seed were almost invariably badly infested or showed evidence of attack of greater or less severity. Specimens of the beetles were taken, mostly dead, in the exhibits of Algeria, Tunis, Spain, and Italy, but some beans damaged by this species were taken in other exhibits, for example, some purporting to come from Porto Rico—perhaps a mistake.

Reports have several times been made of the finding of this species in seeds in various portions of our country, from portions of Canada, and southward to Texas.

The following reason why the species has not before been established in America permanently may be deduced. This weevil, like the pea weevil (*Laria pisorum* L.), produces, as does that species, only a single generation a year and hibernates as an adult in the seeds. Thus the chances are that after the seeds are collected and exported to this country the contained insects are subjected to so much handling and agitation in different ways as to interfere with their proper hibernation, so that by the time the bean plant has attained sufficient growth to produce pods, the beetles are mostly dead or too feeble to propagate. At least this seems to be the case in the Atlantic region and Middle States.

RECORDS OF OCCURRENCE.

September 18, 1909, Mr. I. J. Condit, collaborator of the Bureau of Entomology at San Luis Obispo, Cal., sent living specimens of this weevil in horse beans (*Vicia faba*), which are now being grown quite extensively in that region for feeding stock. They are commonly planted early and are ready to harvest in January or February. Some were planted late, about March 1, but did not produce well on account of the dry season following. When ready for harvest they were found to be infested with this weevil; on account of this and the small size of the pods and beans they were not gathered.

This is without doubt the first notice that we have of the establishment of this species in America. All other records, so far as the writer knows, are of the occurrence of the insect in samples of seed introduced, usually from Europe, into the more northern States and

seldom farther south than Washington, D. C. Unless the insects are dead when received, the active ones die long before the next crop of seed is ready for harvest; in other words, there is no food supply for them, as they do not breed continuously in dry seed, but produce only a single generation a year, as in the case of the related pea weevil (*Laria pisorum* L.).

Thus it happens that although this weevil has probably been brought to this country in seeds every few years for a very considerable period, it has not hitherto become established in the United States. Western conditions are different, and the above notes furnished by Mr. Condit require no further elucidation.

Among the notes of the Bureau of Entomology are many records, more or less brief, of the receipt of this species in seed beans from a number of localities.

May 14, 1894, this species was received from Prof. R. H. Price, College Station, Tex., in beans.

In 1900 (February 9) Mr. A. J. Pieters, of the Bureau of Plant Industry, received this species in broad beans (*Vicia faba*) from Italy.

In 1907 this species was received, December 17, from Reading, England, in a lot of 30 pounds of broad beans containing also a parasite, *Sigalphus* sp.

In 1909 this species was received from several sources. March 8, horse beans infested by this species were received from Mr. Mortimer D. Leonard, New York City, with inquiry if investigations had been made in regard to the insect, which had evidently been introduced from Italy with the beans. September 18 of that year, as has previously been mentioned, we received the insect from San Luis Obispo, Cal.—a record of actual establishment of the species in America. October 4 it was received from Magyar-Obar, Hungary, in horse beans; October 15, from Mr. H. C. Moore, Watsonville, Cal., in horse beans—a second report of occurrence in the United States. October 5 the insect was taken from the seeds of *Vicia faba* collected in California, and from a lot imported from Italy in samples rejected by the United States customs officials as adulterated. October 30, badly infested beans containing this species were received from Italy through the Bureau of Chemistry. During the same year specimens were received from Valencia, Spain.

April 20, 1910, Mr. M. L. Peairs, of the Maryland Agricultural College, reported that a shipment of horse beans seized at the Baltimore customhouse was infested by weevils. The beans were traced to a firm in Berlin, Germany. The samples were infested to the amount of 50 per cent. Identification in this case was made by an assistant, Mr. C. H. Popenoe. Other seizures have been made of this weevil by the Bureau of Chemistry in New York City. Efforts were made to ascertain whether the species was present in other localities

in California, with some success. Thus far indications are that the beans have all been introduced by individuals or firms and not by the Federal or State Governments. Some of these cases have attained considerable newspaper notoriety from the alleged report that the insects were poisonous, a matter which will be taken up later. May 24 this insect was received from Elisanetpol, Caucasus, Russia. In June it was received from Rhodesia, South Africa. Later additional specimens were received from San Luis Obispo, Cal., and February 2, and later in 1911, specimens were received from Sacramento, Cal., collected by Mr. Wm. B. Parker, an agent of this bureau. They were taken in local stores, and were collected in a garden just outside of the city.

In nearly all of these records the insect occurred in broad beans, but in a few cases the records read simply "in beans."

In discussing the introduction of this species into California, and the seizure by the Bureau of Chemistry of horse beans infested by the weevil in New York City, Mr. David Fairchild, of the Bureau of Plant Industry, with whom the writer conferred, desired to know the exact localities other than San Luis Obispo in which the species was known to have become introduced. During the discussion of the advisability of excluding further introductions of the horse bean by firms and private individuals in the Eastern United States, it became apparent that some measure should be enacted, if possible, to prevent the introduction of the beans from California eastward, as there is a greater probability of the introduction of the pest into the Eastern States in beans from California than in beans from abroad.

Altogether, the further introduction of this seed, when infested by living weevils, either from abroad or from California, should be stopped if possible or Federal inspection of all seeds should be made, that the seed stock may be properly fumigated. The California authorities might be empowered to act, but there is no means provided for Federal inspection other than that by the Bureau of Chemistry under the provisions for inspection under the pure food and drugs act of 1906.

NOTES ON OCCURRENCE IN CALIFORNIA.

By Wm. B. Parker, *Agent.*

March 25, 1911, the beetle was first observed and captured on Windsor beans at Sacramento, Cal. The beans ranged in height from 3 to 3½ feet and were in full bloom. Pods of various lengths were present, the longest measuring 3 inches.

By March 30, beetles were active, flying from leaf to leaf or from blossom to blossom and running about on the plants. They were not observed to feed or deposit eggs, although watched closely.

A resident of Sacramento who had some beans in his yard stated that the seed was infested when planted, and that a lot of seed was sent to Mr. Henry R. Russell, Richey, Amador County, Cal., and was planted that spring.

On April 15, the first warm day since April 1, 15 adults were captured on Windsor beans and placed in paper bags over growing beans in order to obtain eggs. While in the bags two pairs were observed copulating and one pair was confined for further observation.

Eggs were observed April 22, cemented to the outside of the bean, and when removed with a camel's-hair brush a fringe of cement was observed attached to the side of the egg.

Many eggs were observed April 25, scattered promiscuously over the pods. Some were nearly ready to hatch, but the greater number were newly laid. No eggs were found on the stems or leaves.

The number of eggs on the various pods were as follows: 4, 8, 5, 15, 2, 3, 16, 10, 6, 3, 2, 4, 2, 8, 2, 5, 6, 7, 5, 10, 11, 34, 11, 14, 25, 10, 6, 20, 27, and 13.

A few adults were observed on the bean pods April 28. They were apparently ovipositing, though the act could not be witnessed. A few seen on the upper leaves were captured, placed in cold storage, and retained for egg laying. Four days later they were removed, and eggs were obtained.

It was observed that the adults, when disturbed, either flew away or contracted their legs and dropped, much as do other weevils when feigning death, but began moving again before they had struck anything in their fall.

May 1, eggs that had undoubtedly hatched were observed to have a dark or black-edged hole under one end, the larva having entered the pod by boring a hole through the side of the eggshell that was attached to the pod and then into the pod itself.

Sixteen eggs were laid May 4. On May 16, distinct dark spots were observed in the ends of the eggs, while the other ends were translucent brownish. The dark spots were very distinct on the 18th, and on the 19th a few eggs had hatched, while others were hatching. All larvæ had emerged by May 20. The egg period in this case was 15 days.

The first hatched egg of those laid May 5 was observed on May 18. Others had hatched May 19. Of the eggs laid May 6 to 7, the first was observed to have hatched on May 18. All but one were hatched on May 19.

These eggs were laid in the field, the adults being inclosed in paper bags which were kept over the eggs as a protection against predaceous insects.

In emerging from the egg the larva was first observed to draw its head back so that the body occupied about three-fourths of the shell. Then it bored down through the side of the shell which was attached to the bean pod, and as the larva entered the pod the end of the egg previously occupied by the abdomen became clear, and finally the entire shell was glassy and transparent in appearance. Just before emerging the head of the larva was quite black and the abdomen seen through the eggshell appeared yellowish.

On July 10, larvæ were observed to be thriving in the beans taken from the vines at Sacramento, Cal., June 20, though the beans were perfectly dry.

August 3, larvæ and pupæ were taken from Windsor beans that were collected in the field at Sacramento June 20 Although some of the larvæ had pupated, they had apparently been in that stage only a very short time. They were pure white and very delicate.

The point where the larva entered the bean was marked by a black dot which had remained from the time that the larva entered.

When the larva was about to pupate a transparent spot appeared on the epidermis of the bean where the larva had eaten out the cotyledon close to the epidermis or seed coat. This transparent spot was not at the point where the larva had entered the bean, but at varying distances from that point.

ALLEGED POISONOUS NATURE OF THE WEEVIL.

The New York Times, under date of September 28, 1909, printed, under the heading "Poisoned Bug Holds Up Imports of Beans," the following "story." The description given shows plainly that *Bruchus rufimanus* is the insect in question.

MANY CUSTOMS LABORERS MADE ILL BY BITE OF LITTLE PESTS FROM ITALY.—INVESTIGATION IS ORDERED.

AGRICULTURAL DEPARTMENT AND BOARD OF HEALTH CALLED IN—VICTIMS OF BITES DEMAND COMPENSATION.

The local pure food office of the Agricultural Department and the board of health have been asked to investigate the coming to this port of a small gray-winged bug that threatens to stop the importation of a certain kind of bean from Italy. This insect has caused so much illness among the laborers and weighers who handle the beans that the matter has been officially brought to the attention of Surveyor Clarkson. He has called for an investigation, and meanwhile has held up a large importation of the beans until a decision shall be reached.

For some time the authorities have received complaint that a small insect brought from Italy with a dried bean, much like our butter bean and called by the men who handle them as "horse" or "fly" beans, was causing the discomfiture of the men handling them. A few days ago three men became so ill that they had to remain at home under the care of physicians. At first the cause of the malady was a mystery, but the men soon became convinced that the bugs were the cause of it. Sixty-three bags of the beans which arrived here on the *Europa* are known to have brought the pests, and the consignment now held up consists of 125 bags, which arrived recently on the *Virginia*.

The insect is of gray color, about the size of half a pea, with wings that fold closely on its back. When first disclosed in the bean the bug is apparently lifeless. It soon revives, however, and begins to crawl or take short flights. It crawls up the trousers of the men who handle the beans and bites them, the effect being a feeling of nausea. In addition to this a rash appears on the affected parts.

The officers of the Pure Food Bureau have taken specimens of the bug, and are now making tests to prove that it is the bug which causes the strange illness.

The men who have the handling of the importations upon the piers and weighers are almost in revolt, and some have petitioned the collector and the surveyor requesting that their doctor's bills be paid, setting up the claim that they are entitled to remuneration as having been infected while in the performance of their duty. They also want pay for lost time, and the matter has been referred to the Treasury Department for decision.

It was said yesterday that the importers to whom the shipments are consigned have protested against the action of the department in holding up their goods.

ALLEGED POISONOUS NATURE DUE TO MITES.

While the writer has not seen any statement to the effect that this weevil is attacked by the predaceous mite *Pediculoides ventricosus* Newport, nevertheless it seems highly probable that the trouble just related may have been due to the presence of this mite in the broad beans affected by the weevil, this supposition being based on the fact

that the writer has observed the mite in great numbers attacking and destroying the related bean and cowpea weevils.[a]

A detailed account of this species with particular relation to its proving noxious to human beings is given by Prof. F. M. Webster in a recent publication of this Bureau.[b]

The writer feels no hesitation in stating that this mite is undoubtedly a parasite of the weevil in question and that it has merely been overlooked by observers, since it is known to prey upon insects of several orders.[c]

The Lariidæ (Bruchidæ) are not classified among poisonous insects, but there are many recorded and unrecorded cases of injury due to insects of the same order; for example, the Meloidæ or blister beetles poison slightly and blisters rise on the bitten places. It is seldom, however, that a human being is bitten more than once or twice at the same time. Several genera of the Buprestidæ, another well-known family of beetles, are frequently accused of biting human beings in the same manner as the Meloidæ, usually on the neck, and they even cause some irritation (but no poison whatever, so far as we know) when they are very abundant in lumber camps.[d]

It is more to the point, however, that we received, March 5, 1909, from Messrs. B. F. Ellington & Co., Atlanta, Tex., examples of two lariids, the four-spotted bean weevil [*Bruchus*] (*Pachymerus quadrimaculatus* Fab.) and the common bean weevil ([*Bruchus*] *Acanthoscelides obtectus* Say), with report that when the infested cowpea seed was being handled, the little insects sometimes covered the bodies of the workmen, raising "wheals" or bumps and actually causing fever.

Under the circumstances, it seems quite probable that when any of this group of weevils occur in great abundance and obtain access to many portions of a human body, the bite may cause considerable irritation, but probably not to all of those having the handling of the infested seed. The fact is established that many persons are poisoned by the attacks of certain insects, while others are immune, or practically so, to insects which more or less habitually sting or bite human beings.[e]

---

[a] U. S. Dept. Agr., Yearbook for 1898, p. 247, 1899.

[b] Cir. 113, Bur. Ent., U. S. Dept. Agr., "A predaceous mite proves noxious to man (*Pediculoides ventricosus* Newport)," pp. 1-24, Apr. 23, 1910.

[c] After the above was written Mr. Wm. B. Parker reported this species of mite preying upon *Laria rufimana* in California.

[d] Frequent reports have been made of the biting, or more properly speaking, piercing, of exposed portions of human beings by various forms of leafhoppers, and many bugs of the suborder Heteroptera are poisonous when attacking susceptible persons. The list could be considerably prolonged.

[e] Thus, one person whom we may designate as *A* does not suffer more than a momentary inconvenience by the bite or sting of mosquitoes and bedbugs. On the other hand, he practically suffers torture from the attacks of fleas and chiggers, the wheals caused by the two insects being of about the same size, usually about that of a dime and persisting for one or two weeks and sometimes even longer, and causing uneasi-

GERMINATION OF SEED.

The opinion, which was very generally held, that the larvæ of bean and pea weevils avoid the germ or embryo, and hence do not cause serious deterioration of the germinating power of the seed, seems to have been more prevalent in Europe in the case of this species than it is now, by seedsmen in America, in the case of related weevils.

GERMINATION TESTS IN EUROPE.

Having doubts as to the value of infested seed for planting, Mr. Theodore Wood performed some experiments in 1885 [12] with seed beans infested by the broad-bean weevil. Twenty beans were selected and sowed under the most favorable conditions for their general welfare. At first, growth was strong and vigorous, but when the fruiting time approached it was noticed that the blossoms were scanty and small and the foliage faded and withered, while in some cases plants had died outright without producing a single pod. The total production measured by the pods was in direct proportion to the amount of infestation, such beans as contained three weevils producing less than those which contained two, while those containing only one weevil produced more pods, as high as 23 being counted in one case.[a]

Subsequently more detailed experiments conducted by the same writer [15] with a larger lot of material and with different varieties of plants proved that the first experiment was on too small a scale to be productive of decisive results. As an instance, Mr. Wood cites the case of one plant, the seed of which was tenanted by six weevils, which bore no less than nine pods, seven of which reached maturity. Among other things, he states that with the five varieties of infested plants tested, namely, Carter's "Leviathan," Carter's "Seville Longpod," two other unnamed varieties of "Longpod," and early "Mazagan," more than one-fourth of the pods, although large and healthy in appearance, proved upon examination to contain only withered germs of the beans. The early "Mazagan," however, proved to be an exception.

---

ness which can scarcely be relieved by any other means than the application of various lotions and vigorous scratching. Many persons claim that after being attacked by "chiggers," which usually cause more irritation than fleas, they finally become immune and are no more troubled. In fact, it may be said that farm hands generally are little troubled by these pests. Many people claim that they are never stung or bitten by fleas; then again we will mention the case of *B*, who is poisoned by mosquitoes as badly as by fleas. To summarize, immunity is secured by experience and there is considerable idiosyncrasy. Nearly all forms of mites which inhabit dwellings and storehouses cause more or less irritation when they become abundant.

This subject is considered somewhat more at length in Circular 77 of this bureau, "Harvest-Mites or Chiggers."

[a] A striking feature in connection with the experiment above mentioned was, according to Mr. Wood, that the plants raised from weeviled seed, with one single exception, altogether escaped the attacks of *Aphis rumicis*, from which scarcely another plant in the same garden was free. From this he inferred that the sap of the weakened plants was of too deteriorated a character to satisfy the fastidious taste of the "colliers."

The final conclusion, however, of both series of experiments is that the presence of the weevils in the seed is highly detrimental, affecting to a very considerable degree the reproductive powers of the future plant and the germinating qualities of the seed, if any is produced. If the germ itself be penetrated the seed naturally is necessarily rendered sterile.

Mr. Wood admitted that the subject was open to further experiment.

GERMINATION TEST OF INFESTED WINDSOR BEANS FROM CALIFORNIA.

March 8, 1912, from a quantity of Windsor beans infested with the broad-bean weevil, furnished by Mr. Parker from California, a number were selected for germination tests.

The beans were classified as uninjured and those showing injury by the presence of from 1 to 5 holes or infestations. These were placed between cloths and covered with moist sand, remaining in this condition for one week. At the end of this time the beans were opened and the number that had germinated were counted. The beans had previously been divided into lots of 50 each.

The percentages of germination as determined by Mr. C. H. Popenoe are as follows:

TABLE I.—*Germination test of infested Windsor beans from California.*

Number of injuries.	Number of beans.	Number germinated.	Per cent germinated.
Perfect	50	37	74
One injury	50	29	58
Two injuries	50	23	46
Three injuries	50	27	54
Four and five injuries	65	21	32.3

Average percentage of injured beans that germinated	47.5
Percentage o uninjured beans that germinated	74.0
Percentage of germinable beans destroyed by weevil	35.8

The above figures show that even in cases where a single individual weevil attacks a broad bean, less than 60 per cent of such infested beans germinate, whereas when four or five beetles find lodgment in a single seed, 32.3 per cent, or about one-third only, germinate. There is no doubt that seeds containing holes made by this beetle are unfit for planting, as, even with perfect germination, the opportunity for the entrance of water into the seeds stimulates decay and the seed frequently rots before germination.

SUMMARY OF NATURE OF ATTACK AND LIFE HISTORY.

The principal injury caused by the broad-bean weevil is due to the operations of its larva feeding within the seeds of broad or Windsor beans and, it is said, peas and some other leguminous seeds, thus

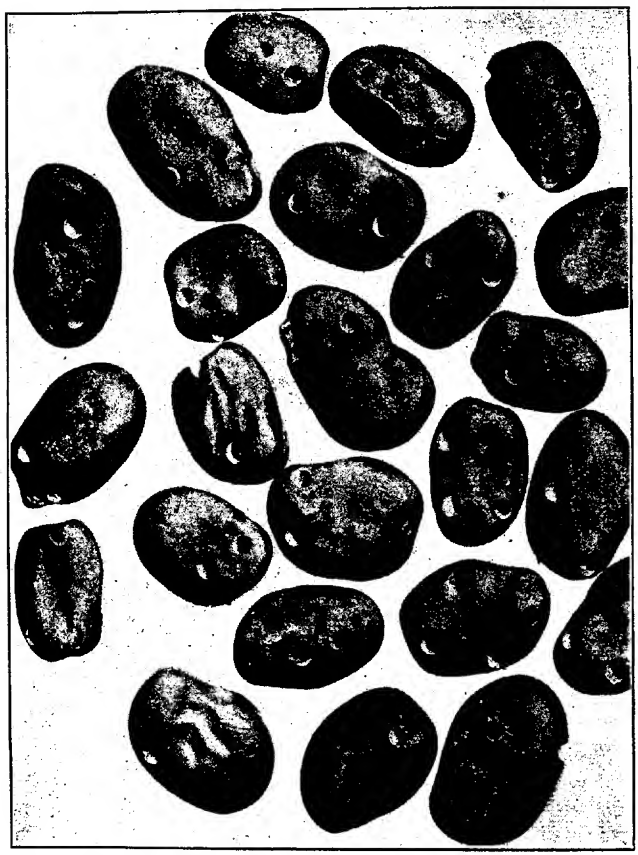

FIG. 16.—Broad beans infested by *Laria rufimana*, showing empty exit holes of beetles, closed exit holes, and open exit holes in which beetles are still present. (Original.)

diminishing their value for sale by loss of weight and by their imperfect or "buggy" appearance (see fig. 16), and also lessening their value as seed material. Where many individuals infest a single seed much

of the tissue is consumed and the germinating power reduced nearly one-half, while the growing power of the plant is also diminished, and there is, moreover, in the case of a plant growing, a much lessened yield of seed, which is also apt to be imperfect.

The method of attack is in brief as follows:

The female weevil begins to deposit her eggs on the young seed vessel in the blossom before and after the former has developed into a pod. Here the eggs hatch and the larvæ penetrate into the growing seeds, each gnawing a gallery for itself, which it lengthens from time to time, as needed. (See fig. 17.) When full grown, the larva transforms to pupa within the accumulated frass and develops later into the beetle stage. This development may take place at different periods, the beetles being found afield in some regions as early as February and until May, some leaving the seed as soon as fully developed and others remaining until they have cut through the skin which remains over the cell while the insect is in the larval and pupal stages. When the beetle wishes to emerge it gnaws around this circular piece of skin and forces its way through.

FIG. 17.—Broad beans split to show ravages made by larvæ of the broad-bean weevil above, and by larvæ and adults below, the latter leaving large pupal cases at the ends of the beans. (Original.)

As is the case with the pea weevil, this species hibernates in the adult condition, and a single generation develops each year. Pupæ have been observed as early as August 3, in California, and the probabilities are that in most seasons the beetles will have developed by the middle of August, or a little later; hence, as they are seen in the field toward the end of March and first of April, it can be deduced that the life of the beetle extends from about the middle of August to the middle of April and later—a period of 8 or 9 months.

The separate periods for the egg, larval, and pupal stages do not appear to have been observed.

LITERATURE AND HISTORY.

The broad-bean weevil was first described by Boheman[1a] in 1833, who designated its habitat as Crimea, Dalmatia, Egypt, and France. From the lateness of this description and the fact that the habitat Egypt is mentioned, it is presumed, and with good reason, that the insect was introduced from Egypt, supposedly the natural home of its favorite food plant, the broad bean. In 1860 John Curtis [2] gave a long account of this species, describing it and its habits and injuries, with reference to earlier writings. He also described three of its hymenopterous parasites. It was not until 10 years later that Riley [3] wrote of the supposed introduction of the insect in America. Rathvon,[4] Glover,[5] and Horn,[7] as well as other writers, seem to have taken it for granted that this species was already introduced from Switzerland into America, basing this supposition on Riley's first editorial note. In later years Fletcher [17] mentions the detection of the insect in broad beans imported from England and found in Canada, but neither he, Hamilton,[18] Lintner,[22] or others assumed the establishment of the species in the United States or Canada.

Of important writings on this species may be mentioned the works of Achille Costa, first published in 1857 and again 20 years later,[9] this account including a description of the egg, larva, and adult, and treatment of the biology. Taschenberg,[10 11] who gave similar accounts, Theo. Wood,[12 15] whose articles will be mentioned later, Miss Ormerod,[14 20 21] and Lintner.[22] Lintner's article, while a detailed one furnishing a somewhat complete bibliography, is largely devoted to a discussion of the synonymy of the species and its reported occurrence in America. Other articles and notes on this species are cited in the appended bibliography.

In this connection it might be mentioned that Olivier, in his treatment of "*Bruchus pisi*" in 1795,[1] evidently failed to differentiate the pea weevil from the species in question and the lentil weevil, since in his illustrations, figure 6, *c*, is recognizable as *pisorum*, while figure 6, *d*, is evidently intended for *rufimanus*. In his concluding notes on "*pisi*" he writes that the larva lives in the interior of peas, lentils, "gesse," beans, and some species of vetch. Moreover, his illustration of *Bruchus granarius* is that of a much smaller insect than *rufimanus* (Pl. I, fig. 10, *a*, *b*), and therefore not the latter species.

NATURAL ENEMIES.

Of the natural enemies of this species very little has been written. John Curtis recorded in 1863 three hymenopterous parasites, which he describes.[2] These are *Sigalphus pallipes* Nees, *Sigalphus thoracicus* Curt., and *Chremylus rubiginosus* Nees.

[a] See Bibliography, pp. 80-82.

FIG. 18.—Broad bean cut in half to show, at top on left, pupal cell of the broad-bean weevil; at right, cell containing predaceous mite (*Pediculoides ventricosus*). Enlarged. (Original.)

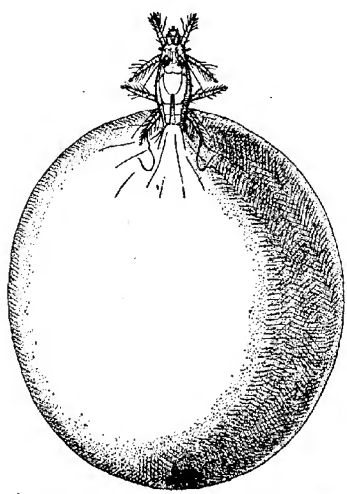

FIG. 19.—Gravid female of *Pediculoides ventricosus*. Greatly enlarged. (Redrawn from Brucker.)

To this list should be added *Pediculoides ventricosus* Newport. Strangely enough, this predaceous mite was not actually observed until 1911, when the species was reported by Mr. Parker at Sacramento, Cal. An illustration is given in figure 18 of a broad bean cut in half, showing the pupal cell of *Laria rufimana* at the left, and at the right another pupal cell showing a mass of females of this mite which have developed within this cell. A gravid female mite is shown in figure 19.

On April 15, 1911, Mr. Parker observed another natural enemy of this species.

A beetle was seen in the clutches of a reduviid bug (*Zelus renardii* Kolen.),.which had its beak thrust through the ventral part of the beetle's abdomen.

The probabilities are also that the insect is devoured in the field, at least in its native habitat, by birds of different species.

EXPERIMENTS WITH REMEDIES.

By WILLIAM B. PARKER, *Agent.*

EXPOSURE TO HEAT OF SUN AS A REMEDY.

Experiment No. 1.—At Sacramento, Cal., August 21, 1911, 50 Windsor beans infested by larvæ, pupæ, and adults of *Laria rufimana* were placed in a black rubber tray and set on a white canvas spread on the roof of the State Insectary. In this situation it was exposed to the sun and protected from the wind. The beans were placed in the sun at 10 a. m., and exposed to the following temperatures until 5 p. m.: 10 a. m., 104° F.; 11.30 a. m., 112° F.; 1 p. m., 116° F.; 2 p. m., 118° F. At 5 p. m. the temperature was below 100° F.

September 13, as none of the insects in these beans had emerged, the beans were opened and the number of living and dead noted. There were no living insects in the beans, but the following is a tabulation of the numbers of larvæ, pupæ, and adults which were found. A check of 20 beans was kept.[a]

TABLE II.—*Heat of sun as a remedy against the broad-bean weevil.*

	Number dead.	Check experiment.	
		Dead.	Living.
Larvæ	20	3	0
Pupæ	25	2	1
Adults	42	1	27
Total	87	6	28
Per cent	100	17+	82+

HOT-WATER TREATMENT

Experiment No. 2.—At Berkeley, Cal., 133 broad beans infested by *Laria rufimana* were placed in water that had just ceased boiling and were left 5 minutes. When removed they were placed in a pan with moist cotton for a germination test. Of this lot, 116 beans sprouted, or 87.2 per cent. The 26 insects found in the beans were dead.

Experiment No. 3.—Beans to the number of 116 were similarly treated, but were left in the water until cool. Four quarts were used. Eighty-three, or 71.5 per cent, of the beans sprouted. All of the beetles were dead.

Experiment No. 4.—Infested beans were placed in hot water that had just ceased boiling and were removed after 1 minute. Fifty-two beetles were removed from the beans and all were dead. No germination test was made.

During the preliminary experiments just recorded it was observed that the adults in Windsor beans were killed if the beans were dipped in water that had just ceased boiling, while the germinating power of the beans was not injured. As soon as enough infested material was obtained for a moderately large-scale experiment, the following tests were made:

[a] These beans were not tested for germination percentage.

Experiment No. 5—Fifteen pounds of infested beans were dipped in 20 gallons of water which had been heated to the boiling point in an iron caldron. The water had just ceased boiling and the beans were allowed to remain in the water 5 minutes.

Experiment No. 6.—A second lot was dipped for 1 minute. The effect upon the beetles and upon the germinating power of the beans may be expressed in tabular form, as follows:

TABLE III.—*Hot-water treatment against broad-bean weevil and its effects on germinating power of treated beans.*

Temperature.	Time of immersion.	Number beans counted.	Percentage of beetles killed.	Percentage of germination.
°F.	*Minutes.*			
210	5	98	100	2.0
210	1	111	100	38.7

From the preceding data it is evident that on a large scale, at least, the germinating power of the beans is seriously injured. The germination was not injured by the small-scale treatments of a similar nature.

Experiment No. 7.—In another test the infested beans were placed in cold water in the iron caldron and the temperature gradually raised. The first beans were removed when the temperature reached 140° F. and the last at 170° F. The results of these experiments follow:

TABLE IV.—*Hot-water treatment against broad-bean weevil and its effects on germinating power of treated beans.*

Temperature.	Time of immersion.	Number beans counted.	Percentage of beetles killed.	Percentage of germination.
°F.	*Minutes.*			*Per cent.*
130	23	76	94	86.0
140	27	130	100	98.4
150	32	129	100	88.3
160	39	91	100	82.4
170	43	116	100	56.8

It is evident from the foregoing data that 140° F. is the lowest temperature at which all of the insects are sure to be killed and that the germinating power of the bean is not seriously injured until the temperature reaches 160° F. or over.

When removed from the water the beans were somewhat soaked, but were in good shape for planting.

METHODS OF CONTROL.

Possibility of eradication.—The broad-bean weevil is by no means a difficult species to control and if proper action could be enforced there is every probability that the insect could be stamped out in its limited occurrence in this country. This would, however, in all probability require special legislation. By the abandonment, in the infested district, of the culture of broad beans, and possibly other beans and other large legumes which might furnish the insect with food, this result could be accomplished, if at the same time soaking and fumigation of seed, "holding over," and other remedies were

practiced. One condition might militate against the effectiveness of a stamping-out process, which is that there is a possibility that the insect might find food in some wild leguminous plant producing a seed large enough for its development, for example, one of the vetches, or other related wild plant, or some plant that has escaped from cultivation. Although this contingency is a doubtful one, still the project is one requiring further study with this end in view. Otherwise the remedies are practically the same as for the pea weevil, allowing of course for different food habits.

The hot-water remedy.—In regard to direct remedies, the late Dr. James Fletcher, experimenting in 1888, demonstrated that soaking broad beans in water for 24 hours drowned every specimen of the weevils present in the samples which he had for the purpose. This expedient, if not applied when the seed is first harvested, should be employed before the time of sowing the seed. The hot-water treatment, with an exposure of, say, 15 minutes, as employed by Mr. Parker in his experiments with cold water gradually heated to 140° F., is obviously a more certain remedy.

Writing of the possibility of the breeding of this species in food plants other than broad beans, Mr. Parker stated, March 18, 1912, that it seems possible that the other leguminous seeds come too late for the beetles to oviposit upon the pods. The Windsor beans are planted in November and ripen very early, while the other legumes are not planted until spring and do not ripen until quite late in the season.

In the practical carrying out of this remedy a piece of burlap is placed in a caldron so that when weighted down with the beans it will not touch the bottom or sides. This keeps the beans from coming into contact with the heating surface and prevents them from becoming overheated. The beans are then placed on the burlap and covered with water and the fire started. The temperature should be raised as rapidly as possible, the beans stirred constantly, and when the thermometer reads 140° F. the beans should be immediately removed. They may then be planted or spread out in a thin layer to dry.

Holding over seed.—As in the case of the related pea weevil, holding over seed for a second year in a tight bag or other receptacle will be found sufficient. The beetles, if kept in a warm room, will emerge prematurely and will die without injuring the beans afterward, as they are unable to breed in dry seed.

Fumigation.—Fumigation with bisulphid of carbon, at the rate of about 2 or 3 pounds of the chemical to each 1,000 cubic feet of air space for 48 hours, is a perfect remedy in an air-tight receptacle, as in the case of other bean and pea weevils.

While a smaller amount of this chemical—1½ pounds to 1,000 cubic feet, with an exposure of 36 hours—is sometimes advised and is theo-

retically correct, i. e., for absolutely air-tight inclosures, there is great difficulty in securing such a degree of tightness; hence greater strength and longer exposure are desirable. On the other hand the rate advised by many is excessive, especially when three days' exposure is also advised.

In some cases hydrocyanic-acid gas at the usual rate of 10 ounces of cyanid of potash to 1,000 cubic feet will be found useful, where for any reason bisulphid of carbon is considered undesirable. This remedy has not been tested for this species in its occurrence in broad beans, but it has been successfully employed against related weevils and it should not be difficult for this gas to penetrate a mass of these larger seeds.

In the practical fumigation of beans, peas, and similar seeds with bisulphid of carbon it should be first understood that the more nearly air tight the receptacle the more perfect the fumigation. Infested seed should be placed in large barrels, which should then be closed tightly, or in specially made fumigating boxes, bins, or small houses. After filling the receptacles with the seed the bisulphid is poured into evaporators, for which purpose tin pie plates are most valuable, placed on the top of the seed. The gas, being heavier than air, descends through the mass of seed, and, properly applied according to directions, will kill all of the insects contained. At the end of about 48 hours, which is sufficient for perfect fumigation under these conditions, the seed should be removed and thoroughly aired before being packed away for storage. If left in the receptacles, the dead bodies are apt to decay, and thus injure the seed for food or planting.

The usual precautions not to bring fire of any kind, such as a lighted cigar, into the vicinity of the place where the operation is being performed should be observed. Where the covers or doors of the receptacles do not fit perfectly tight, paper should be carefully pasted over.

In any form of leguminous seed the penetrating power of bisulphid of carbon, hydrocyanic-acid gas, and other gases is as nearly perfect as could be wished.

CONSTRUCTION OF A FUMIGATOR.

The extensive pea growers of our Northern States, especially in New York and Michigan, have largely adopted what was known in former years as Tracy houses, named after Prof. W. W. Tracy, now of this department, and also called "bug houses," for the fumigation of peas affected by the related pea weevil. The opinion is somewhat prevalent that in spite of the fact that we can control the broad-bean and pea weevils by means of heating, soaking, and similar mechanical methods, everything considered, fumigation on a large scale, while a little more expensive, is more thorough and requires less labor. The same is true of grain and other material in general

affected by weevils and insects of similar habits. The simplest and least expensive remedy consists in the establishment of a quarantine or fumigating building, bin, or box, to be made as nearly air tight as possible, in which the peas, beans, or other infested material can be placed as soon as harvested. After fumigation, if properly conducted, the broad beans or other material can be safely placed in permanent storage without danger of reinfestation from the species which is being considered.

A building, box, or room of about 100 to 200 bushels capacity suitable for the fumigation of a quantity of beans, peas, or grain would contain about 500 cubic feet. A fumigator of this cubic capacity might be built 8 feet square by 8 feet in height. A good, and perhaps the best, preventive for the escape of the gas would be to line the fumigator with sheet tin, with soldered joints, and over sheathing. Another method would be to sheath the room inside, cover the walls, ceiling, and floor with tarred or heavy building paper, with the joints well lapped, and cover the inside with matched ceiling boards. The fumigator should always be equipped with a tight door, in which the joints have been broken, similar to the door of a refrigerator or safe, and should close with a refrigerator catch against a thick felt weather strip, which should render it practically gas tight. Thus constructed it would furnish sufficient space for the fumigation of about 200 bushels of seed material. There would also be sufficient space for the application and diffusion of the carbon bisulphid from the top with a charge of more than necessary for the amount of seed treated.

It is highly desirable to have this fumigating building isolated, because of the danger in the use of bisulphid of carbon, its inflammability, and liability to affect live stock. The writer has had personal experience with several such fumigators in Washington, D. C., and with one in Chicago years ago. The latter was constructed from an iron boiler and was fitted with a metallic door similar to those used in large bank safes. In this fumigator the writer was successful in destroying weevils and other insects in stored grains in 24 hours, using it at the minimum rate of 1 pound to 1,000 cubic feet of air space. In his experience in the use of more loosely constructed fumigators and other containers, peas, beans, and other useful legumes can be satisfactorily fumigated even more easily than can stored cereals. In recent experiments, in specially prepared fumigators which we are now using, it was found best to use 2 pounds to 1,000 cubic feet of air space. It is much better, also, to fumigate at a comparatively high temperature than at a low one, and an exposure of from 36 to 48 hours is better than one of 24 hours. After constructing a fumigator on the lines which have been indicated, the operator will be able to determine the best quantity of insecticide and the length of exposure

to his own satisfaction. Perfectly air-tight inclosures are difficult to obtain unless specially constructed with this particular end in view.

A fumigator of the type described is illustrated by figure 20. It has a capacity of 100 cubic feet and is supplied with a pair of tight-closing handles, which are a necessity to prevent warping. Of three fumiga-

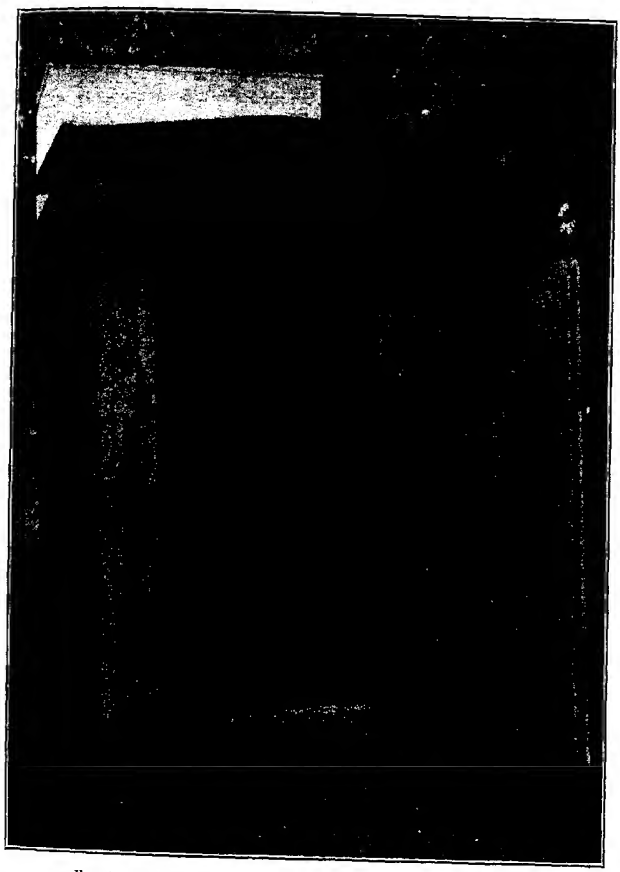

FIG. 20.—Fumigator used for stored products infested by insects. (Original.)

ors of similar pattern one was constructed with a single handle, which was not according to specification, and warped badly in consequence.

It should be added that in order to destroy insects in a fumigator or other inclosure at a temperature much below 50° F. a larger quantity of the bisulphid of carbon is necessary than when the temperature is about 80° to 90° F.

Dry heat.—In the series of experiments made by Mr. Parker in California, the exposure to the heat of the sun as a remedy is significant, but it is not certain what effect this would have if applied on a large scale. A series of experiments along this line should be made, and should also be carried on with other species of weevils in beans, peas, and cowpeas. This remedy has several times been suggested and probably some persons have already made tests of it, but we have no definite records to that effect. One of the best ways would be to place the infested seed on metal, such as roofing tin, especially if the temperature is particularly high, i. e., above 100° F.

Impossibility of prevention.—As in the case of other bean and pea weevils, there is no known method of preventing the ravages of the insect in the field, except the timely application of remedies before the seed is planted. It is not impossible that a certain degree of immunity from injury might be obtained by either very early or very late planting. This remains to be learned. In the case of choice plants grown for experimental purposes protection could be secured by the use of cloth screens as has been advised for such insects as the strawberry weevil and the root maggots.

Importation of parasites.—The insect might be held partly in check at least by the introduction of one or more of three hymenopterous parasites which have been previously mentioned.

BIBLIOGRAPHY.

The broad-bean weevil has a considerable bibliography under the two names of *Bruchus rufimanus* and *B. granarius* auct. The following list of references is not intended to be complete, since many notes and articles which have been consulted are technical, short, contain no original matter, or are not of value in a consideration of the present topic. Twice as many references are available as will be quoted in the following list:

1. Boheman, C. H.—Schoenherr's Genera et Species Curculionidum, vol. 1, p. 58, 1833.

Original description as *Bruchus rufimanus* "*Habitat in Tauria, Dalmatia, Ægyptia et in Gallia meridionali.*"

2. Curtis, John.—Farm Insects, London, pp. 361–367, fig. 53, 5–10, 1860.

Description, habits, injuries, and references; description of hymenopterous parasites *Sigalphus pallipes* Nees., *S. thoracicus*, n. sp., and *Chremylus rubiginosus* Nees. Mention as *B. granarius.*

3. Riley, C. V.—Amer. Ent., vol. 2, pp. 126–127, fig. 85, 1870.

Editorial note on supposed introduction of "*Bruchus rufimanus*," with quotations and illustrations from Curtis.

4. Rathvon, S. S.—Amer. Ent., vol. 2, p. 119, 1870.

A three-page article on *Bruchus obtectus* mentioned as *obsoletus* Say, in which Stephens's brief description of *rufimanus* is quoted. Brief editorial notes.

5. Glover, T.—Rept. Comm. Agr., p. 71, 1870 (1871).

Note on supposed introduction from Switzerland into New York.

6. RILEY, C. V.—3d Rept. Ins. Mo., pp. 50–52, 1872.

Natural history, etc. (after Curtis); a practical transcription of No. 2.

7. HORN, G. H.—Trans. Amer. Ent. Soc., vol. 4, p. 313, 1873.

Technical description of the species, with mention of receipt of specimens reared from pea pods imported from Switzerland.

8. LAWSON, R.—Ent. Mo. Mag., vol. 9, p. 217, 1873.

Brief note on "swarming" of beetles on shipboard off Scarborough, England.

9. COSTA, ACHILLE.—Degl. Insetti, pp. 269–273, pl. 11, fig. c, Napoli, 1877.

A second edition of the author's original account, first published in 1857, including description of the egg, larva, and adult and an account of the biology.

10. TASCHENBERG, E. L.—Brehm's Thierleben, p. 178, fig. , Leipzig, 1877.

A short popular account of the insect, mentioned as the bean-beetle, with original illustration.

11. TASCHENBERG, E. L.—Praktische Insektenkunde, vol. 2, pp. 263–264, Bremen, 1879.

A popular illustrated account including description of adult, larva, and life history.

12. WOOD, THEO.—Ent. Mo. Mag., vol. 22, p. 114, 1885.

Experiments with infested beans, showing that such seed, while not injurious to the germinating qualities, is highly prejudicial to reproduction. Plants raised from weeviled seed with a single exception escaped attack of *Aphis rumicis*.

13. BAUDI, FLAMINIO.—Deutsche Ent. Zeitschr., Heft 2, p. 404, No. 20, 1886.

Technical description in Latin; mention as *Mylabris rufimana*.

14. ORMEROD, ELEANOR A.—9th Rept. Inj. Ins., pp. 6–8, figs. 1–8, 1886.

A two-page report, with quotations and illustration from Curtis, and recommendations.

15. WOOD, THEO.—Trans. Ent. Soc. Lond., for 1886, pp. 375–380.

On the germination of beans infested with this species. A more detailed account than that given in No. 12, with somewhat different conclusions.

16. WHITEHEAD, CHAS.—2d Ann. Rept. Agr. Adviser, pp. 49–51, fig. 17, 1888.

A two-page account, including notice of injury and consideration of life history and of prevention.

17. FLETCHER, JAMES.—Rept. Minister of Agr., Canada, pp. 55–56, 1888.

Mention of detection in broad beans imported from England and found in Canada. Quotation from Miss Ormerod, with recommendations.

18. HAMILTON, JOHN.—Trans. Amer. Ent. Soc., vol. 16, p. 150, 1889.

Listed among insects common to Europe and North America.

19. LUNARDONI, A.—Gli Insetti Nocivi, vol. 1, pp. 262–266, Napoli, 1889.

Technical description of the adult, egg, larva, and pupa; consideration of geographical distribution, biology (after Costa), and remedies.

20. ORMEROD, ELEANOR A.—12th Rept. Inj. Ins., pp. 19–24, figs. 1–8, 1889.

A five-page account, with many references to injuries in England, and recommendations for preventing losses.

21. ORMEROD, ELEANOR A.—Manual Inj. Ins., 2d ed., pp. 59, figs. 1–8, 1890.

A three-page account, with description, nature of injury, and detailed suggestions for prevention and remedies.

22. LINTNER, J. A.—7th Rept. Ins. N. Y., pp. 279–285, 1891

A detailed compiled account, with full bibliography; references to reported occurrence in the United States and Canada; stated not to be naturalized in the United States. Remarks on characters, synonymy, distribution, and remedies.

23. [CHITTENDEN, F. H.]—Ins. Life, vol. 6, p. 220, February, 1894.

Listed as among species collected in exhibits of broad beans at the Chicago Exposition in 1893.

24. Journal Board of Agriculture, vol. 3, pp. 33–36. London, June, 1896.

A four-page account, with no indication of author, evidently mostly compiled.

25. CHITTENDEN, F. H.—Yearbook U. S. Dept. Agr., 1898, p. 247 (1899).

Short popular account in comparison with other bean weevils, not yet acclimated in America.

26. Leaflet 150, Board of Agriculture and Fisheries, 4 Whitehall Place, London, S. W., England, pp. 3–4, fig. 2, November, 1905.

Popular account, with remedies.

27. SCHILSKY, J.—Käfer Europas, vol. 41, p. 22, Nürnburg, 1905.

Systematic technical account, with bibliography.

28. FALL, H. C.—Trans. Amer. Ent. Soc., vol. 36, p. 161, July 26, 1910.

Characters for separating this species from *pisorum;* not known that the species is established with us.

29. CHITTENDEN, F. H.—Bul. 82, Pt. VII, Bur. Ent., U. S. Dept. Agr., p. 92, February 13, 1911.

Brief notice of introduction at San Luis Obispo, Cal.

ADDITIONAL COPIES of this publication may be procured from the SUPERINTENDENT OF DOCUMENTS, Government Printing Office, Washington, D. C., at 5 cents per copy